



Earth Habitable 4 Billion Years Ago

[Source: DTE](#)

Why in News?

Recently, analyses of ancient rocks and minerals revealed that Earth may have had the **necessary conditions** to support life **around 600 million years** after its formation, with **fresh water and dry land** present as far back as **4 billion years ago**.

What are the Key Highlights of the Recent Study?

- **Water Cycle and Life Emergence:** The interaction between freshwater and land, referred to as the [water cycle](#) might have created conditions conducive to life.
 - This interaction was previously believed to have **started around 3.5 billion years ago based on [fossil evidence](#)**.
 - A study of [oxygen isotopes](#) in ancient rocks reveals the origins of Earth's water cycle.
 - It suggests fresh water and land interactions occurred several kilometres **below [the Earth's surface](#)**, challenging the theory that Earth was completely covered by [ocean](#) **four billion years ago**.
- **Implications for Early Life:** These findings indicate that the conditions for life to flourish existed relatively early in Earth's history.

What are the Key Facts About Origin of Earth?

- **Age of Earth:** While Earth is estimated to be around **4.5 billion years old**, the study suggests that fresh water and dry land were present as far back as 4 billion years ago.
- **Theories Related to the Origin of Earth:**
 - **Nebular Hypothesis:** It was given by **Immanuel Kant** and revised by Laplace.
 - It considered that the **planets were formed out of a cloud of material** associated with a youthful sun, which was slowly rotating.
 - In 1950, Otto Schmidt in Russia and Carl Weizascar in Germany revised the **nebular hypothesis**.
 - They considered that the sun was surrounded by a [solar nebula](#) containing mostly **hydrogen, helium**, and dust.
 - The friction and collision of particles led to the formation of a disk-shaped cloud and the planets were formed through the process of accretion.
 - **Big Bang Theory:** It was given by **Edwin Hubble, in 1920**. It is the idea that the universe began as just a single point, then expanded and stretched to grow as large as it is right now.

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Geological Time Scale

Eons	Era	Period	Epoch	Age / Years Before Present	Life / Major Events
	Cainozoic (From 65 million years to the present times)	Quaternary	Holocene Pleistocene	0 - 10,000 10,000 - 2 million	Modern Man Homo Sapiens
		Tertiary	Pliocene Miocene	2 - 5 million 5 - 24 million	Early Human Ancestor Ape: Flowering Plants and Trees
			Oligocene Eocene Palaeocene	24 - 37 Ma 37 - 58 Million 57 - 65 Million	Anthropoid Ape Rabbits and Hare Small Mammals : Rats – Mice
	Mesozoic 65 - 245 Million Mammals		Cretaceous Jurassic Triassic	65 - 144 Million 144 - 208 Million 208 - 245 Million	Extinction of Dinosaurs Age of Dinosaurs Frogs and turtles
	Palaeozoic 245 - 570 Million	Permian		245 - 286 Million	Reptile dominate-replace amphibians
		Carboniferous		286 - 360 Million	First Reptiles: Vertebrates: Coal beds
		Devonian Silurian		360 - 408 Million 408 - 438 Million	Amphibians First trace of life on land: Plants
		Ordovician Cambrian		438 - 505 Million 505 - 570 Million	First Fish No terrestrial Life : Marine Invertebrate
	Proterozoic Archean	Pre-Cambrian 570 Million - 4,800 Million		570 - 2,500 Million 2,500 - 3,800 Million	Soft-bodied arthropods Blue green Algae: Unicellular bacteria
	Hadean			3,800 - 4,800 Million	Oceans and Continents form – Ocean and Atmosphere are rich in Carbon dioxide
Origin of Stars	5,000 - 13,700 Million			5,000 Million	Origin of the sun
Supernova				12,000 Million	Origin of the universe
Big Bang				13,700 Million	

▪ Evolution Of The Earth:

- **Formation of the Lithosphere:** Initially, Earth was extremely hot and volatile. As it cooled, **heavier elements like iron sank towards the centre**, while lighter materials rose to the surface, forming the crust.
- **Evolution of Earth's Atmosphere in Three Stages.**
 - First, the loss of primordial atmosphere.
 - Second, the **hot interior of the earth** contributed to the evolution of the atmosphere. The **process through which the gases were outpoured from the interior is called degassing.**
 - Finally, the **atmosphere** was modified by the living world through the process of **photosynthesis** and volcanic activity.
- **Development of the Hydrosphere:** As Earth cooled, water vapour in the atmosphere condensed and fell as rain, filling the planet's depressions to form oceans.
- **Impact of Biological Processes on Atmosphere:** Photosynthesis began to flood the atmosphere with oxygen paving the way for more complex life forms that rely on oxygen.
- **Origin of Life:** A kind of **chemical reaction**, which first generated **complex organic**

molecules and assembled them.

THEORIES OF EVOLUTION

The modification of living organisms during their descent, generation by generation from common ancestors.

Oparin-Haldane Theory of Origin of Life

- ↳ Also known as Materialistic theory
- ↳ Describes process of origin of life on early Earth as:

Physio-chemical processes of atoms → Organic compounds → Macromolecules → First living system or cells

Theory of Inheritance of Acquired Character (Lamarckism)

- ↳ First theory of organic evolution
- ↳ **Evolutionary ideas:**
 - ↳ Internal forces of life increase the size of organism
 - ↳ New structures appear because of an 'inner want'
 - ↳ Direct environmental effect over living organisms
 - ↳ Inheritance of acquired character
- ↳ **E.g.;** Long neck of giraffe due to gradual lack of surface vegetation

Theory of Natural Selection (Darwinism)

- ↳ Foundation of evolutionary biology
- ↳ **Elements:**
 - ↳ Universal occurrence of variation
 - ↳ Rapid multiplication
 - ↳ **The struggle for existence** - Intraspecific and interspecific
 - ↳ **Survival of the fittest (Natural Selection)**
 - ↳ Inheritance of useful variations; Elimination of non-useful variations
- ↳ **E.g.;** Survival of more dark-winged moths than white-winged ones in post-industrialisation period

Neo-Darwinism

Integration of Darwin's theory of evolution with Gregor Mendel's theory of genetics

Modern Synthetic Theory

- One of the proven theories of organic evolution
- Includes factors such as – Mutation, Variation /Recombination, Heredity, Natural Selection and Isolation

Mutation Theory (Hugo de Vries)

- ↳ Describes evolution as a jerky process where new varieties of species are formed by mutations (discontinuous variations)
- ↳ **Salient features:**
 - ↳ Mutation appears all of a sudden and becomes operational immediately
 - ↳ Same type of mutation in several individuals of a species
 - ↳ All mutations are inheritable
 - ↳ Useful mutations are selected and lethal ones are eliminated by nature



UPSC Civil Services Examination, Previous Year Question (PYQ)

Prelims:

Q. Which of the following pairs is/are correctly matched? (2008)

Theory/Law Associated Scientist

1. Continental Drift : Edwin Hubble
2. Expansion of Universe : Alfred Wegener
3. Photoelectric Effect : Albert Einstein

Select the correct answer using the code given below:

(a) 2 and 3 only

(b) 3 only

(c) 2 only

(d) 1 only

Ans: (b)

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